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Indian Standard

SPECIFICATION FOR ISOLATING TRANSFORMERS FOR AIRPORT LIGHTING SYSTEMS

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MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 3

February 1989

Indian Standard

SPECIFICATION FOR ISOLATING TRANSFORMERS FOR AIRPORT LIGHTING SYSTEMS

0. FOREWORD

0.1 This standard was adopted by the Bureau of Indian Standards on 24 November 1987, after the draft finalized by the Illuminating Engineering and Luminaires Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 All aviation ground lighting (AGL) circuits are designed as high voltage series circuit loops with a series isolating transformer feeding each fitting and each circuit fed from a constant current regulator. Isolating transformers covered by this specification are of completely enclosed rubber covered type suitable for use on 6·6 or 20 ampere series airport lighting circuits having nominal voltage ratings of 5 000 V.

0.3 In preparing this standard, assistance has been taken from FAA Advisory Circular No. 150/5345-47 (1975), issued by the Department of Transportation, Federal Aviation Administration, USA.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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*Rules for rounding off numerical values (*revised*).

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1. SCOPE

1.1 This specification covers the requirements for series isolating transformers for use in airport lighting systems.

2. TERMINOLOGY

2.1 Isolating Transformers — A current transformer, whose primary winding is connected in a series high voltage circuit, desinged for continuous operation with the electricity isolated secondary winding which may be open circuited/short-circuited/loaded up to its rating.

2.2 Connector Kits — Means of terminating airport lighting cables in plug and socket arrangements for easy isolation and connection.

3. REQUIREMENTS

3.0 Workmanship — The transformer, including all parts and accessories, shall be constructed and finished in a thoroughly workmanlike manner. Particular attention shall be given to neatness, throughness of soldering, wiring, impregnation of coils, freedom of case and leads from burrs and sharp edges, open pores in the case moulding material, and firmness of case moulding to transformer lead sheath.

3.1 Component Parts — The transformers shall consist of primary and secondary coils wound upon a core and enclosed in a waterproof case with rubber connections moulded on the primary and secondary leads.

3.2 Materials — Materials shall be as specified herein. When materials are not specifically designated, they shall be of the best commercial quality and entirely suitable for the purpose.

3.3 Design and Construction — The transformers shall be designed and constructed so that no parts will work loose in service. They shall be built to withstand the strains, jars, vibrations and other conditions incident to shipping, storage installation and service. The exact shape and design of the transformers shall be optional provided all requirements specified herein are met and the maximum dimensions specified hereinafter are not exceeded.

3.3.1 *Windings* — The windings shall be insulated from each other and the core. Windings of the core assembly shall be tightly wound and secured prior to moulding so as to reduce the possibility of turns becoming loose and being forced close to the outer surface during-pressure-moulding operations. The transformers shall be designed to operate indefinitely under load, short-circuit, or open-circuit conditions in the secondary with rated current and rated frequency in the primary. The transformers shall have sufficient capacity to allow for lamp aging, secondary lead losses and contact losses.

3.3.2 *Operating Conditions* — The transformers shall be constructed for continuous outdoor service at any ambient temperature from a minimum of −20°C to a maximum of +55°C. They shall operate properly when submerged in the ground with up to 5 000 volts on the primary winding.

3.3.3 *Frequency* — The transformers shall be designed to operate satisfactorily at rated frequency.

3.3.4 *Electrical Characteristics* — The electrical characteristics of the transformers shall be shown in Table 1.

3.4 Details of Components

3.4.1 *Case* — The transformers shall be enclosed in permanently sealed cases in such a manner as to produce a completely watertight assembly. No portion of the case shall be less than 0·6 cm thick, and it shall be free of cracks, blisters, holes, etc, which would be detrimental to transformer service life. Sharp corners and edges of the core and coil assembly shall be eliminated or adequate provisions made so that they will not cut the case if the transformer is dropped or handled roughly. The case shall be constructed so that moisture accidently getting into the leads of connectors cannot be conducted through the leads into the windings of the transformer. The case shall be composed of material formed directly on the core and coil assembly or preformed and compound filled. The material shall meet the physical requirements in accordance with the relevant Indian Standards. The minimum strength requirements shall be at least the following:

Tensile strength — 84 kg/cm².

Tensile strength after 96 hours oxygen bomb test — 70 kg/cm².

Tensile strength after 168 hours in an oven test at 80°C ± 1°C — 70 kg/cm².

Durometer hardness — 65 ± 10.

Insofar as practicable, internal air pockets shall be eliminated and the assembly shall be sufficiently rugged to withstand rough handling. The case shall be capable of withstanding exposure to sun, oil, gasoline, moisture, acid and alkalin soils. The case shall be designed so that the transformer may be installed upright or lying on any side. The dimension of the transformer shall be such that the transformer shall fit easily into the space defined as a cylinder, 25 cm in diameter by 30 cm in height.

The junction of the case with the sheath of the leads shall not crack or show evidence of damage when the transformer is carried out by one lead, or when the leads are bent or twisted as they normally would be during testing and installation. The case shall form a permanent watertight junction with the leads. At the junction, the case compound shall provide a reinforcing area for the leads. At the case surface the reinforcing shall be at least 25 percent greater than the outside diameter of the connecting leads. The reinforcing may be of a cone shape around individual leads or a continuous ridge enclosing all three leads, and shall form an integral bond with the entire cable sheath within this reinforcing cone or ridge. There shall be no improper moulding or bonds as evidenced by bubbles, blisters, cracks, etc. The case of the completed transformer shall be firm to the touch at all points and show no indentation (except for compression of case compound) when subjected to pressure which can be exerted directly by the hands.

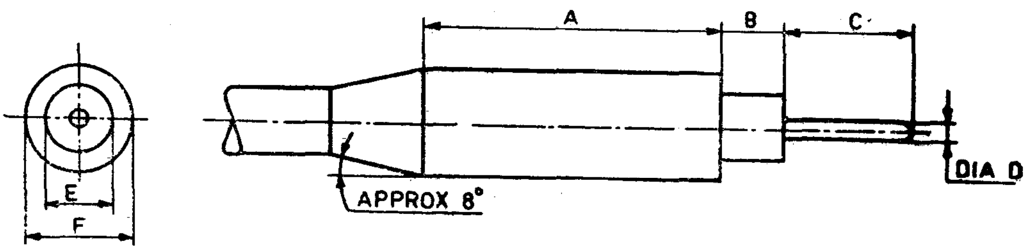
3.4.2 *Transformer Leads* — The transformer shall be provided with a two-conductor

TABLE 1 ELECTRICAL CHARACTERISTICS

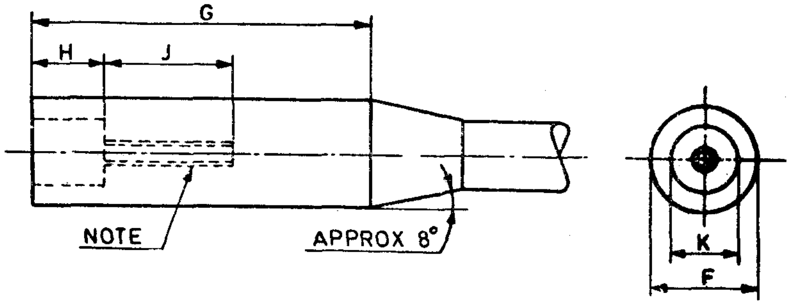
(*Clauses* 3.3.4, 5.3 *and* 5.6)

PRIMARY			PERCENT EFFICIENCY	SECONDARY AMPERES		SECONDARY	
Watt	Amperes	Power Factor Percent		Full Load	Short-Circuited	Load Ohms	Maximum Open Circuited Voltage-RMS
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
30/45	6·6	95	80	6·53-6·67	6·6-7·1	1·15	25
30/45	20·0	95	80	—	—	1·15	25
45	8·3	96	81	6·47-6·73	6·66-6·94	1·03	13
65	8·3	96	84	6·47-6·73	6·66-6·94	1·49	19
65	6·6	95	80	—	—	1·60	30
100	6·6	95	85	—	—	2·44	70
100	20·0	95	85	—	—	2·44	70
200	8·3	96	88	6·47-6·73	6·66-6·94	4·60	60
210	6·6	95	90	—	—	4·82	100
210	20·0	95	90	6·53-6·67	6·6-7·1	4· 2	100
300	6·6	95	90	19·8-20·2	20·0-22·0	0·90	70
300	20·0	95	90	19·8-20·2	20·0-22·0	0·90	70
300	6·6	95	90	6·53-6·67	6·6-7·1	8·25	135
300	20·0	95	90	6·53-6·67	6·6-7·1	8·25	135
500	6·6	95	90	19·8-20·2	20·0-22·0	1·35	70
500	20·0	95	90	19·8-20·2	20·0-22·0	1·35	70

NOTE — Voltage rating shall be Primary 5 000 volts and Secondary 600 volts.



A) Plug

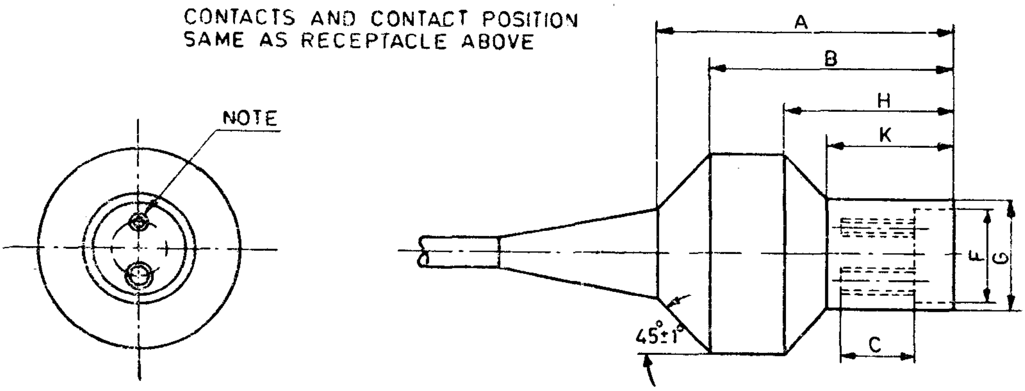


B) Receptacle

Note — Metal sockets shall be recessed not more than 3·20 mm below inside face of receptacle and before splitting shall have an ID of 4·80 ± 0·03 mm.

Dimensions	*Millimetres*	*Dimensions*	*Millimetres*
A	60 *Min*	*F*	23·80 + 0·00 − 0·80
B	15·00 + 0·40 − 0·00	*G*	70·00 *Min*
C	27·00 ± 0·40	*H*	15·00 + 0·00 − 0·40
D	4·70 ± 0·03	*J*	27·00 *Min*
E	15·30 ± 0·10	*K*	14·50 ± 0·10

Fig. 1 Plug and Receptacle, Single Conductor, 25 Ampere, 5 000 Volts to Ground



Note — Metal sockets shall be recessed not more than (3·20 mm) below inside face of receptacle and before splitting the large socket shall have an ID of 4·00 ± 0·03 mm and the small socket shall have an ID of 3·20 ± 0·03 mm.

Dimensions	*Millimetres*	*Dimensions*	*Millimetres*
A	66·70 ± 0·8	*G*	25·40 + 0·00 − 0·80
B	54·00 ± 0·8		
C	16·3 *Min*	*H*	38·10 ± 0·8
F	17·60 + 0·25 − 0·00	*K*	28·60 ± 0.8

Receptacle, Type II, Class A, Style B

Fig. 2 Plug and Receptacles, Two Conductors, 20 Ampere, 600 Volts Between Contacts, 1 500 Volts to Ground

secondary lead and two single-conductor primary leads. Lead connections may be of the solder or of the solderless type. If solderless connectors are used in joining leads to the transformer winds, they shall be of a type designed for that application and properly applied. Care shall be exercised during moulding to ensure that proper clearance exists between these connections after the moulding operation has been completed. All three leads shall emerge from one end of the transformer. Spacing and arrangement are optional, provided all other requirements are complied with. The leads shall be securely fastened to the transformer in such a manner that carrying by a single lead will not loosen the electrical connections or affect the water seal. The length of all transformer leads shall be measured from the connector face to the junction of the transformer case.

3.4.2.1 *Primary leads* — One primary lead shall be equipped with a plug type connector generally conforming to Fig. 1. The other primary lead shall be equipped with a receptacle generally conforming to Fig. 1. The cable for the primary leads shall be 19/0·75 mm (corona and ozone proof) single core cable, annealed tinned copper conductor insulated with butyl rubber or ethylene propylene rubber (EPR) and (PCP) sheathed suitable for 5 000 V operating voltage. Each primary lead shall extend 60 ± 7·50 cm beyond the housing, including the cable connector.

3.4.2.2 *Secondary leads* — The secondary lead shall be equipped with a receptacle conforming to Fig. 2. The cable for secondary lead shall be 37/0·30 mm (corona and ozone proof) twin core cable, annealed tinned copper conductor, butyl rubber or ethylene propylene rubber (EPR) insulated, taped, laid and filled and sheathed with special type of PCP suitable for 650 volt operating voltage. The cable shall extend 120 ± 7·50 cm beyond the housing, including the cable connector.

NOTE 1 — For selection of cables guidance may be taken from IS : 9968 (Part 1)-1981* and IS : 9968 (Part 2)-1981†.

NOTE 2 — The drawings indicated in Fig. 1 and 2 are typical only. In case the purchaser desires different dimensions, these shall be furnished to the supplier and dimensions shall be subject to mutual agreement.

3.4.2.3 A watertight cap shall be placed on each connector for protection during shipment and installation. The cap shall consist of a rubber or rubber-like compound plug (or receptacle) designed to protect the mating surfaces of the connector from moisture and dirt.

3.5 Weight — The weight of the transformers shall be held to the minimum consistent with good design.

3.6 Connector Kits — Requirements are under consideration.

4. MARKING

4.1 The following markings shall be moulded on the case surface of the transformer:

a) Manufacturers' name or trade-mark;
b) Transformers rating, watts-volts-frequency;
c) Tranformer, series-to-series;
d) Primary amperes;
e) Secondary amperes; and
f) Volts 5 000 Hz.

4.2 The isolating transformers may also be marked with the Standard Mark.

NOTE — The use of the Standard Mark is governed by the provisions of the Bureau of Indian Standards Act 1986 and the Rules and Regulations made thereunder. The Standard Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. Standard Marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers, may be obtained from the Bureau of Indian Standards.

5. TESTS

5.1 Classification of Tests

5.1.1 *Type Tests* — The following shall constitute the type tests:

a) Visual examination (*see* **5.2**);
b) Ratio test (*see* **5.3**);
c) Test for voids (*see* **5.4**);
d) Insulation resistance test (*see* **5.5**);
e) Characteristics test (*see* **5.6**);
f) Shock test (*see* **5.7**); and
g) Temperature rise test (*see* **5.8**).

5.1.1.1 The type tests shall be conducted on three random samples to prove compliance with this specification. Unless otherwise specified, all tests shall be made at room temperature (approximately 25 ± 5°C), using an approximate sine wave power source with primary current maintained at the specified values by means of an auto transformer. It is necessary for water bath temperature to be substantially different from limits set above, the proper temperature coefficient for the compound being used may be applied when computing insulation resistance values. It will be manufacturer's responsibility to furnish proof that the coefficient used is correct. Proof shall be in the form of a certified test report furnished by the manufacturer. Joints between transformer leads, and between transformer leads and test leads will not be taped during any of the dielectric or insulation resistance tests required by **5.5**. All test lead connectors shall be checked with a 'GO' and 'NO GO' prior to use to assure proper watertight seal.

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*Specification for elastomer insulated cables: Part 1 For working voltages up to and including 1 100 volts.

†Specification for elastomer insulated cables: Part 2 For working voltages from 3·3 kV up to and including 11 kV.

5.1.2 *Acceptance Tests* — For the purpose of acceptance tests all the tests specified under type tests shall be carried out.

5.1.2.1 The sampling procedure and criteria of acceptance shall be subject to agreement between the supplier and the purchaser. In the absence of such an agreement, the sampling procedure detailed in Appendix A may be followed.

5.1.3 *Routine Tests* — The following shall constitute the routine tests:

a) Visual examination (*see* **5.2**);
b) Ratio test (*see* **5.3**);
c) Test for voids (*see* **5.4**); and
d) Insulation resistance test (*see* **5.5**).

Note — For the purpose of acceptance and routine tests, insulation resistance test specified under **5.5.2** shall be carried out for one cycle only.

5.2 Visual Examination — Each transformer shall be examined visually for good workmanship.

5.3 Ratio Tests — Test each transformer for current ratio at rated frequency of current on the primary and rated load on the secondary. The secondary current of each transformer must conform to the limits specified in Table 1.

5.4 Tests for Voids — The maximum pressure which can be exerted directly with the hands shall be applied to all parts of the transformer cases. Any evidence of voids beneath the surface of the case shall be cause for rejection.

5.5 Insulation Resistance Tests — The transformers shall be subjected to the following tests.

5.5.1 *Hot Water Immersion Test* — The sample transformers with mating connectors should be completely immersed in water at 55° ± 2°C for the period of 2 hours. This insulation resistance measured should not be less than 300 megohms for secondary and 750 megohms for primary, after 1 minute, when measured at 5 000 V and 15 000 V dc respectively, as mentioned in Table 2.

TABLE 2 INSULATION RESISTANCE VALUES

(*Clauses* 5.5.1 *and* 5.5.3)

Coil	DC Test Voltage	Minimum Insulation Resistance in Megohms			
		Cold	ELC*	Hot	ELC*
(1)	(2)	(3)	(4)	(5)	(6)
Secondary	5 000	750	6·7	300	17·0
Primary	15 000	2 000	7·5	750	20·0

*Equivalent leakage current (microamps).

5.5.2 *Twenty Cycle Test* — The transformer shall be subjected to a continuous 20 cycle tests as follows:

5.5.2.1 *Mating connectors* — Mating connectors that were gauged with 'GO' and 'NO GO' gauges shall be installed in the three connectors of the transformers. The mating connectors shall not be removed before completion of the 20-cycle testing. If they are removed for any reason, tests shall be repeated so that the transformers and their connectors satisfactorily pass 20 continuous cycle. One cycle shall consist of the sequence of operation specified in **5.5.2.2** to **5.5.2.4**.

5.5.2.2 *Transformer* — The transformers shall be operated with mating connectors installed for a minimum of 6 hours in air at room temperature with rated current flowing in primary coils. The secondaries of the transformers shall be open-circuited. The procedure of this paragraph shall be hereinafter be referred to as 'the heating cycle'.

5.5.2.3 *Water immersion test* — Immediately following the heating cycle, the transformers with leads and connectors shall be completely submerged in water, which is grounded at room temperature. Care should be taken to insure that all moulded connections on transformer leads and test hardness are completely immersed in water during this test. Immediately after immersion, the insulation resistance of each coil and lead assembly shall be measured. The time period between interruption of the heating cycle and start of the measurement shall not exceed 3 minutes.

5.5.2.4 *Soaking* — The transformers and their connectors shall be soaked in water, at room temperature, for not less than 12 hours, and the insulation resistance measurements repeated.

5.5.3 *Resistance Measurements* — Measurements of dielectric and insulation resistance shall be made with direct current. The test voltage shall be applied for one minute between each coil and ground with the other coil grounded and its connectors submerged in water. The insulation resistance at the test voltage indicated shall equal or exceed the minimum values specified in Table 2. Zero and maximum readings of the test instrument shall be periodically checked by touching the high voltage lead to the water surface and suspending it in air. After instrument needle settles down following current in rush, it shall remain steady without fluctuations.

5.6 Characteristics Test — The samples shall be tested to show that their electrical characteristics are as specified in Table 1. All corrections necessary to compensate for meter-power consumption shall be applied. The transformers shall be operated in air at room temperature with rated load connected to the secondary until the transformer windings have reached normal operating temperature at which time the measurements will be taken.

5.7 Shock Tests — The sample transformers shall be dropped twice from a height of 2 metres on a smooth hardware floor; once so they hit on a bottom corner or location where the most damage is likely to occur due to the core cutting into the case, and once so they hit on a side or location where the most damage is likely to occur to the windings. Lead rigidly shall be tested by securing (just below the connector) each lead, one at a time, in a clamp fastened to a support, elevated a distance in excess of the length of leads and then releasing the transformers for a free fall from the clamp elevation. The lead clamp used shall be such as to not cause damage to the lead at the point of attachment. After the completion of these test the transformers shall be tested to ensure that they meet the secondary current requirements at rated load. A change of more than one percent from the results obtained in the test specified in **5.6** or evidence of damage to the case and attaching leads shall be cause for rejection.

5.8 Temperature Rise — The temperature rises of the transformers shall be determined by the resistance method and shall not exceed 55°C, when the transformers are operated in air under each of the following conditions with rated current flowing in the primary:

a) Rated load,
b) Short-circuit, and
c) Open circuit.

The temperature tests shall be conducted in accordance with the applicable requirements of IS : 2026 (Part 2)-1977*. Temperature rise shall be computed from the following formula:

Temperature rise (°C)

$$= (234{\cdot}5 + \phi) \frac{(R_1 - R_0)}{R_0}$$

where

ϕ = temperature (°C) corresponding to cold resistance,

R_0 = cold resistance, and

R_1 = hot resistance.

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*Specification for power transformers: Part 2 Temperature rise (*first revision*).

APPENDIX A

(*Clause* 5.1.2.1)

SAMPLING PLAN FOR ACCEPTANCE TESTS

A-1. LOT

A-1.1 All the transformers of the same rating manufactured from the same material under similar conditions of production shall be grouped together to constitute a lot.

A-2. SCALE OF SAMPLING

A-2.1 For judging the conformity of a lot to the requirements of the acceptance tests, sampling shall be done for each lot separately. For this purpose, the number of transformers to be selected at random from each lot shall depend upon the size of the lot and shall be in accordance with Table 3.

TABLE 3 SAMPLE SIZE AND ACCEPTANCE NUMBER

Lot Size	For Visual Examination, Ratio Test, Test for Voids and Characteristics Test		For Other Acceptance Tests	
	Sample Size	Acceptance Number	Sample Size	Acceptance Number
(1)	(2)	(3)	(4)	(5)
Up to 150	20	1	8	0
151 to 300	32	2	13	1
301 to 500	50	3	13	1
501 to 1 000	80	5	20	1
1 001 and above	125	7	32	2

A-2.2 In order to ensure the randomness of selection procedures given in IS : 4905-1968* may be followed.

A-3. CRITERIA FOR CONFORMITY

A-3.1 The number of transformers selected at random in accordance with col 1 and 2 of Table 3 shall be subjected to the visual examination requirements, ratio test, test for voids and characteristics test. A transformer failing to satisfy any of the requirements of these acceptance tests shall be termed as defective. The lot shall be considered as conforming to the requirements of these acceptance tests if the number of defectives in the sample is less than or equal to the corresponding acceptance number given in col 3 of Table 3; otherwise not.

A-3.2 A lot which has been found as conforming to the above requirements shall then be tested for the other acceptance tests. For this purpose, the sample size and acceptance numbers are given in col 4 and 5 of Table 3, respectively.

A-3.3 The lot shall be considered as conforming to the requirements of acceptance tests, if **A-3.1** and **A-3.2** are satisfied.

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*Methods for random sampling.

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